

Recent upgrades at GFZ Potsdam laser station preparing remote and autonomous operation

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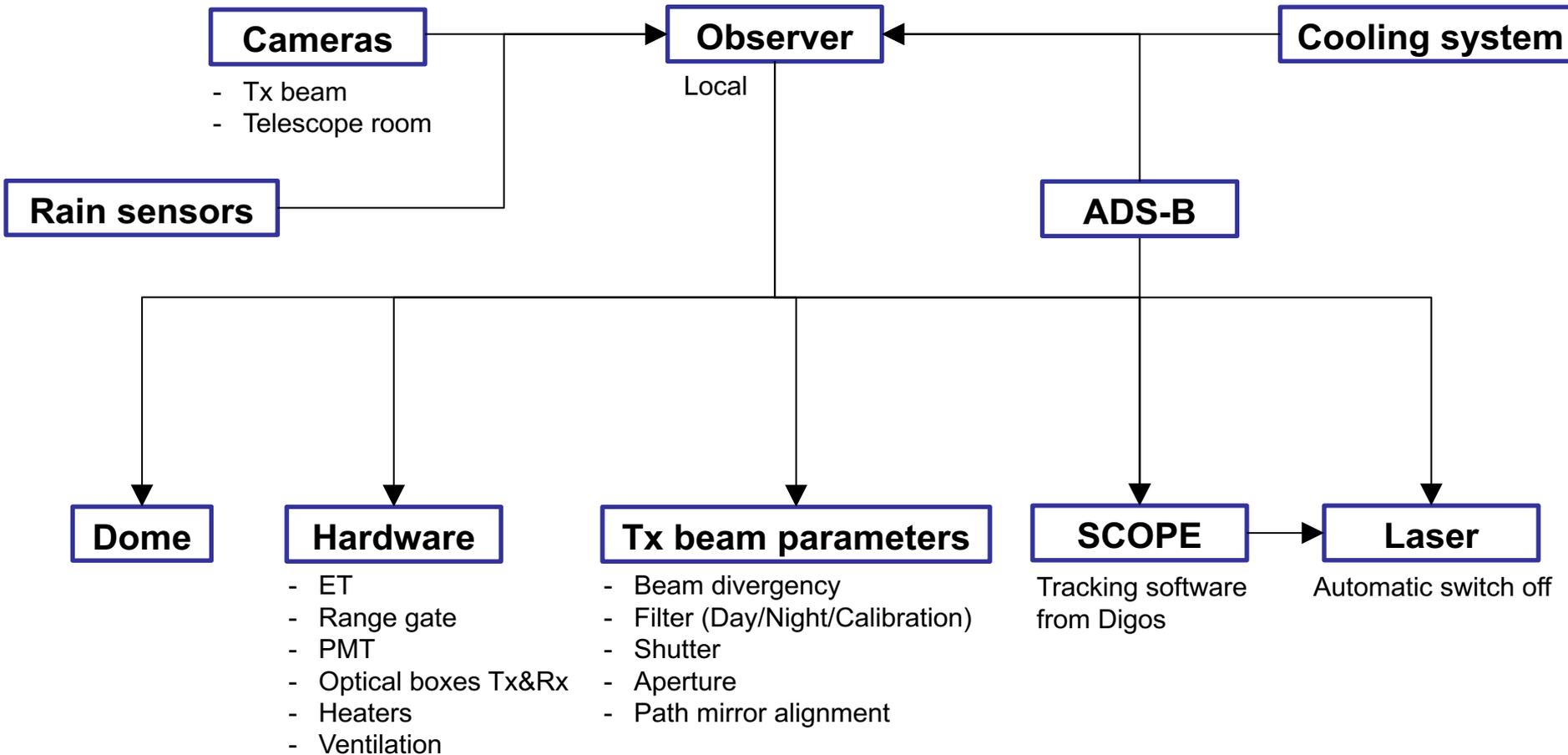
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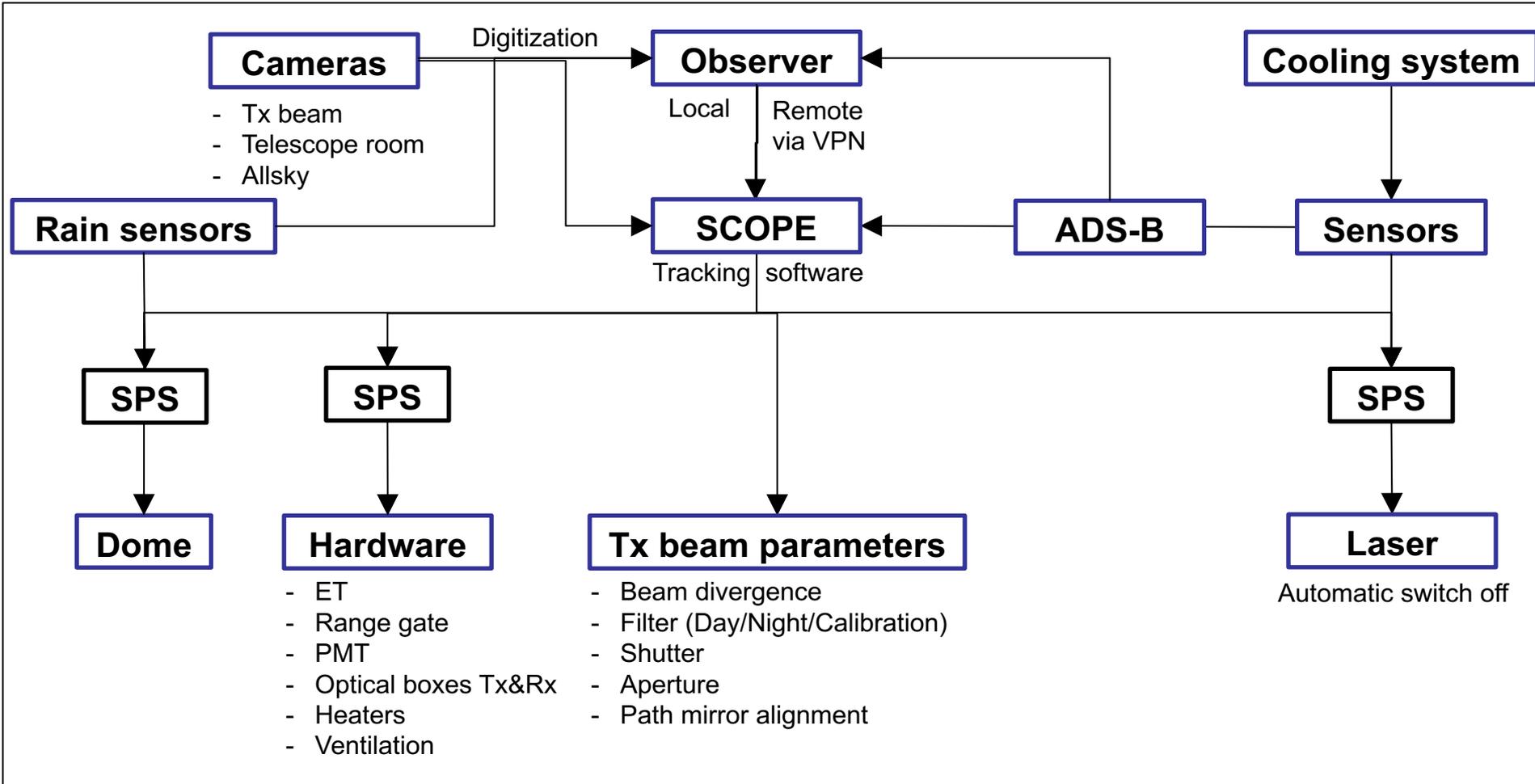
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Former system setup



Upgraded system setup



Further upgrades

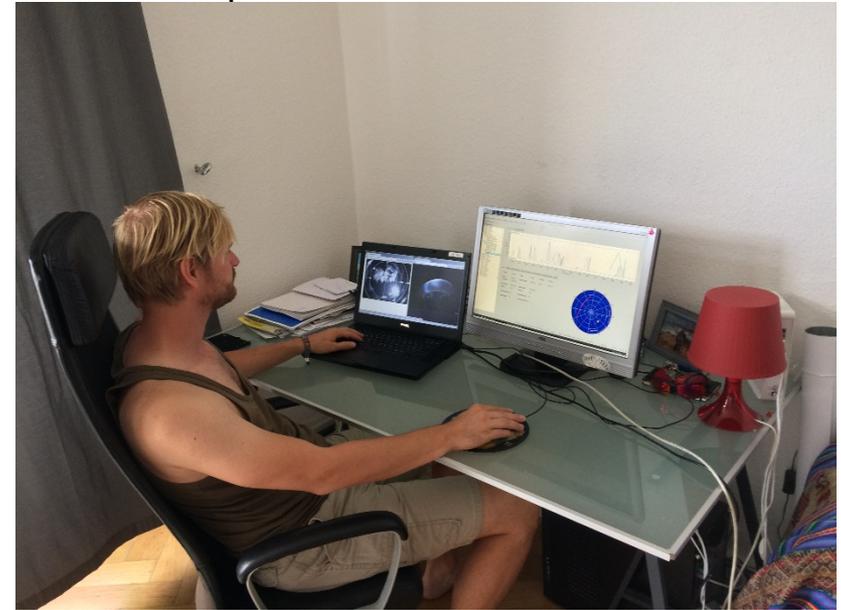
- **SCOPE – DiGOS tracking software – upgrades**
 - Mount models from automatic star calibration (automatic adjustment of many stars)
 - Control of Tx beam alignment
 - Prediction manager (download and calculation of passes in the background)
 - Graphical and automatic scheduling
- **Hardware**
 - Secured shutters, that snap back upon signal loss due to a spring
- **Cameras**
 - Allsky

Remote operation tests

- On site via LAN (GFZ)
 - Via cable in LAN
- From home via internet (Potsdam/GFZ, Berlin/GFZ)
 - Via cable in Internet, but also via Hotspot from mobile phone

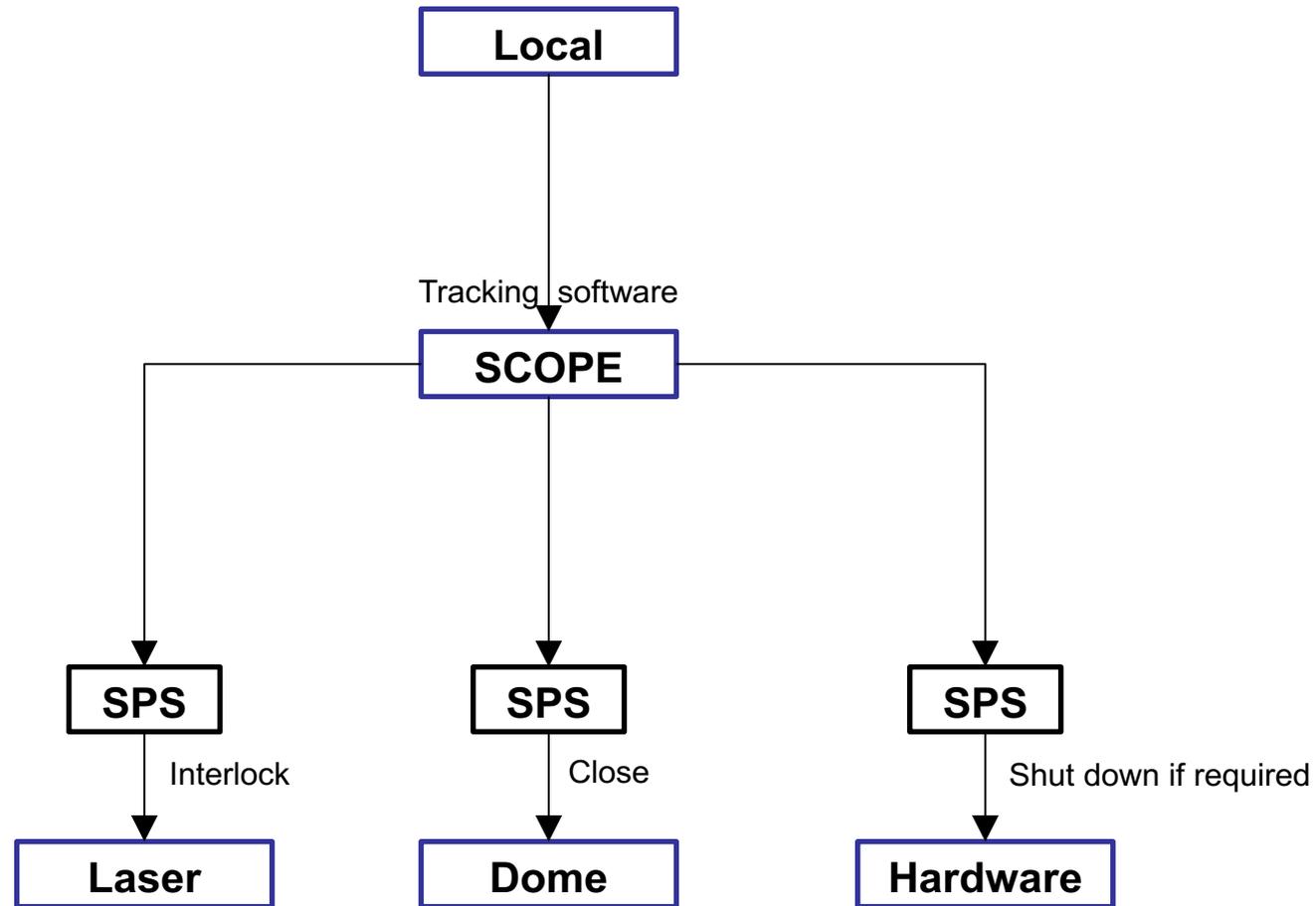


Setup used for onsite remote tests.

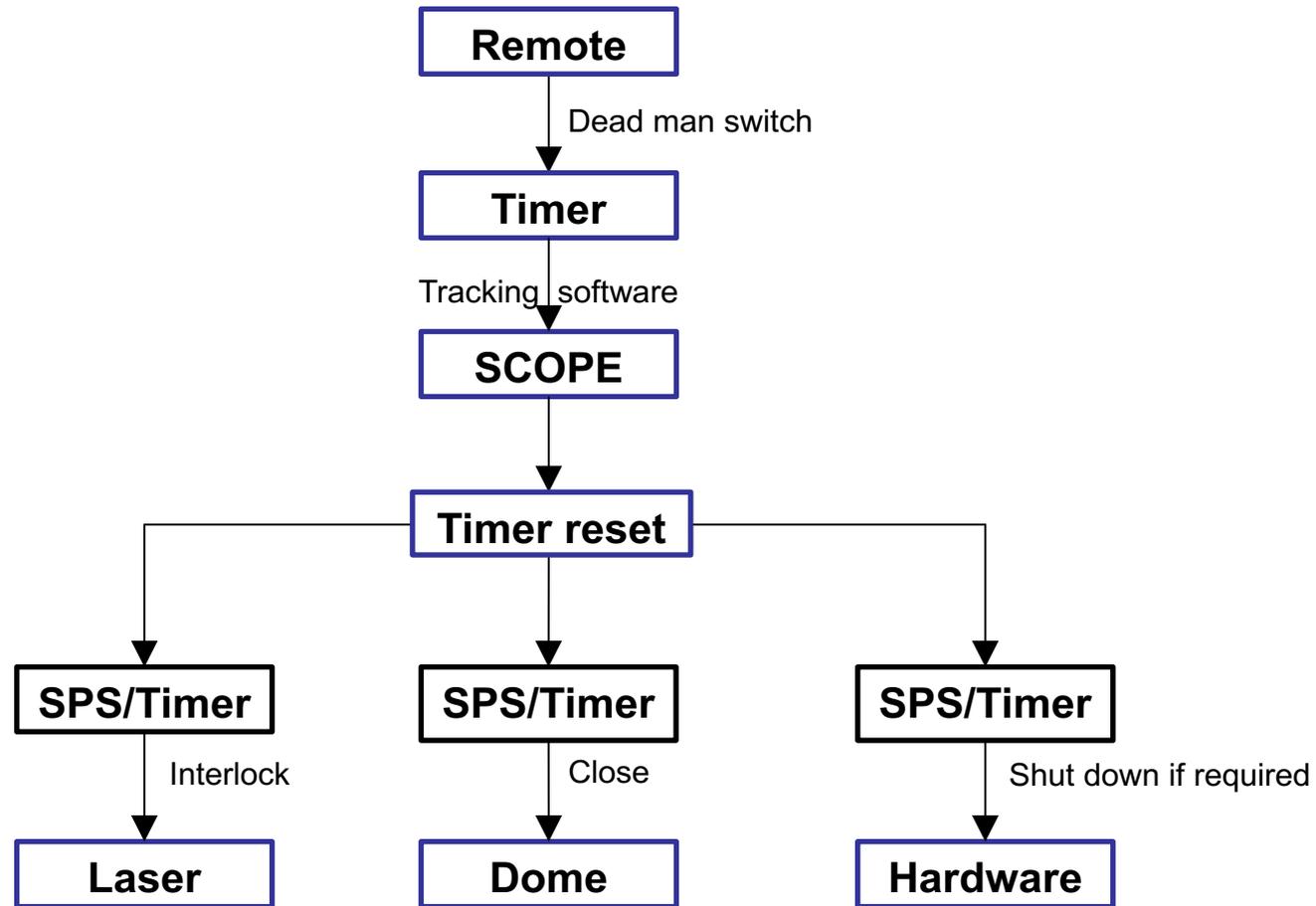


Setup used for remote tests from home.

Remote operation safety concept



Remote operation safety concept



Steps towards autonomous operation

- Hardware now ready to be controlled by software
- Safety barriers about to be implemented
- Basis for actually implementing autonomous operation
- Software has to be extended with various modules
 - Optimization of Signal via adjustment of
 - Tx beam alignment offset
 - Tx beam divergence
 - Time bias
 - Make use of
 - Time bias prediction
 - Tx beam alignment offset prediction (Heatmaps from our database)
 - Cloud detection?

Summary

- System setup and hardware upgraded (SPS, digitization, etc.)
- Hardware can now be switched from the tracking software
- Safety barriers are about to be implemented
- Secure remote operation becomes possible
- Hardware setup is prepared to incorporate autonomous tracking
- Software modules have to be developed and incorporated

Thank you for your attention!

Laser upgrade

- HighQ laser PicoRegen Nd:VAN, 532 nm, 12 ps pulse width, 20 ns timing jitter back from Spectra Physics in Austria after upgrade
 - Before
 - 1.0 W with 0.5 mJ pulse energy @ 1 kHz
 - 0.8 W with 0.4 mJ pulse energy @ 2 kHz
 - After
 - 1.1 W with 1.1 mJ pulse energy @ 1 kHz
 - 1.4 W with 0.7 mJ pulse energy @ 2 kHz
 - Status
 - Integrated and currently under testing
- Used for tests Compiler Nd:XXX, 532 nm, 7 ps pulse width, 50 ns timing jitter, from Passat Ltd.
 - Performance
 - 0.14 W with 0.35 mJ pulse energy @ 400 Hz

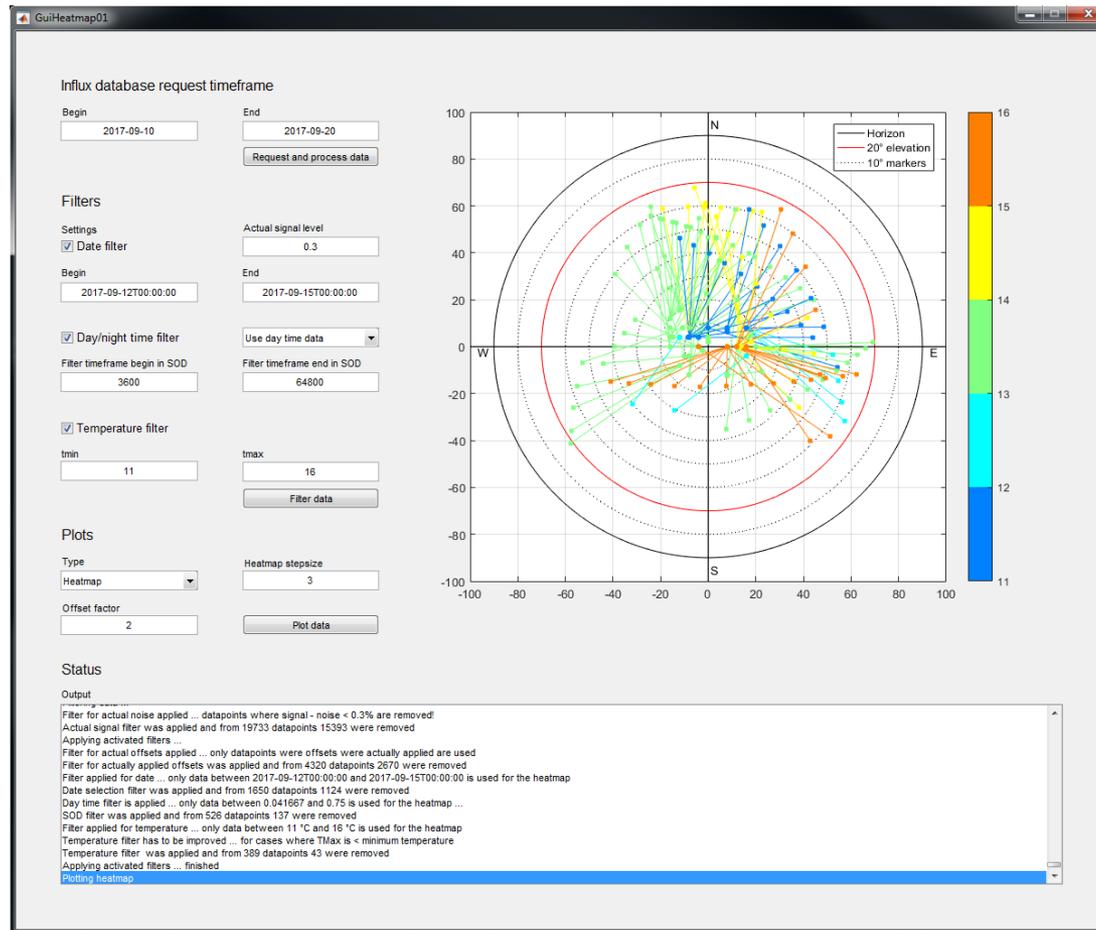
Further hardware upgrades

- Temperature stabilization of the telescope system



POT3 system being wrapped up.

Tx beam pointing offset analysis



Hardware upgrades

- Upgrading control hardware to SPS
 - Switching power (PMT, RG, optical boxes Tx/Rx, heater, laser, ventilation)
 - Changing state (dome, Rx path detector and camera, shutters in Tx and RX path with snap back mechanism)
 - Including new sensors (Laser cooling circuit, laser room temperature and dehumidifier status, rain sensor)
- Adding cameras
 - Allsky Cam
 - Wide angle telescope room camera
- Digitizing existing camera streams
 - Via framegrabber card
 - Switching unit to input a larger number of streams than 2 per card
 - Cameras used for the laser beam alignment, mount models, tracking (Tx cam)

Remote operation safety concept

- Safety barriers developed
- Concept
 - Only local operation
 - At the station
 - Via VPN
 - Connection timeout for the control software SCOPE for the
 - Operator (manual dead man switch)
 - Hardware (continuously reset timer in the SPS)
 - Rain sensor
 - 1 out and 1 inside
 - Closes or prevents opening of the dome
 - ADS-B radar
 - Laser operation is interrupted automatically if airplane is close to beam
 - Real time monitoring system with
 - A database and a frontend for relevant system parameters
 - Email notifications about computer status